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ON THE DEVELOPMENT OF *ASCARIS LUMBRICOIDES* L.

SADAO YOSHIDA
Pathological Department, Osaka Medical Academy, Osaka, Japan

Development of uninjured fertilized eggs. Leuckart reported that in the hot summer months the eggs may develop and form an embryo in two weeks. In my experiments 15 to 18 days was the minimum length of time required, and in the great majority of the eggs 30 days was necessary, even in the summer months. Widely varying stages of development are found in a single culture. The optimum temperature is 28 to 34° C., room temperature being favorable to rapid development during the summer.

Lutz, Epstein and others have proposed various means of producing an embryo within the shell. In the present experiments a sample of fresh feces mixed with water was put into a large test tube (or small beaker) and the contents stirred with a glass rod and filtered through a sheet of gauze. The sediment remaining in the test tube is mixed again with water and the filtration repeated. After this process is repeated two or three times most of the eggs will be found in the filtered fluid, from which they are collected by centrifugation. By removing the rubber plug from the bottom of a short tube the egg masses that accumulate are easily transferred into Petri dishes or other shallow vessels. A small quantity of aseptic moistened sand is added and the dish covered with a piece of gauze and a glass cover to protect from flies, and at the same time to allow free admission of air. This culture method is quick, easy and safe. The eggs can easily be separated from the sand because of the difference in specific gravity. The dishes are put into an incubator at 28 to 34° C. in the winter or left at room temperature in the summer months and must be kept moist. Exposure to strong direct sunlight checks development, and if continued, will kill the eggs.

When development is finished the full grown, coiled embryo within the shell is very active, especially in a warm temperature. Such eggs as these are said to be mature and are able to infect the body of the host when taken into the alimentary canal. Experiments were begun in May, 1916, and have been continued up to the present time save for interruptions due to accident.

Non-infectiveness of Unripe Eggs

That eggs in the various stages of development short of maturity do not develop into the embryo in the alimentary canal of the host, but are evacuated in the feces is proved by the following experiments.

Experiment I. May 15, 1916. Seven guinea-pigs were fed with eggs from feces evacuated on the preceding day which showed little or no signs of beginning division. Three days later three of the pigs were killed. No eggs were found in the stomach and very few in the small intestine, but a good many in the cecum and large intestine. None showed any evidences of development.

May 25, 1916. Two more of the pigs were killed. No eggs were found in the alimentary canal.

June 22, 1916 (thirty-seven days after feeding). The remaining two guinea-pigs were killed and examined. No eggs whatever were found.

Experiment II. July 30, 1917, 3 p. m., a rat was fed with eggs 14 days old. July 31, 9 a. m., fecal examination showed small quantities of eggs. Three hours later larger quantities were found. August 1, fecal examination negative. August 3, eggs in abundance in the feces. August 4, 8 a. m., eggs in abundance in feces; animal killed at 9 a. m.; the organs, especially liver and lungs, examined for larvae but with negative results. Liver and lungs both normal.

Experiment III. August 31, 1917, a rat was fed with eggs 15 days old. September 1, 9 a. m., fecal examination showed a small number of eggs. September 2, 8 a. m., animal died. A few eggs were found at autopsy in the intestine, but no embryos.

Experiment IV. September 2, 1917, 2 p. m., a rat was fed with unripe eggs. September 3, 8 a. m., fecal examination revealed no eggs. September 4, 8 a. m., abundant eggs in feces; 12 m., animal killed and the organs, especially liver and lungs, examined for larvae, but with negative results.

None of the eggs used in the foregoing experiments had reached the mobile embryo stage.

Hatching Place of Eggs

Both stomach and intestine have been suggested by various authors as possible hatching places of the ripe eggs in the animal or human host. I have carried out both incubation and feeding experiments to determine the hatching place of the eggs. Ripe eggs placed in 0.8 per cent. salt solution and incubated at 38° C. for 5 days did not hatch, nor did ripe eggs hatch when incubated for 6 days at 37 to 38° C. in gastric juice. The experiment was repeated with a 1 per cent. solution of sodium bicarbonate as medium with the same results.

Experiment V. August 3, 10 a. m., a mouse was fed with ripe eggs 59 days old. August 4, 8 a. m., numerous eggs were found present on fecal examination. 1 p. m. (twenty-seven hours after feeding) the mouse was killed. The stomach contained numerous eggs, one half hatched embryo, and three free embryos. The intestine contained three embryos and a good many eggs. Numerous eggs were found also in the cecum and large intestine.

Experiment VI. August 6, 4 p. m., two mice were fed with mature eggs 62 days old. August 7, 9 a. m. (seventeen hours after feeding) one mouse was killed. A small number of eggs were present in the stomach and small intestine, and numerous eggs in the cecum and large intestine, but no embryos. 11 a. m. (nineteen hours after feeding) the other mouse was killed. Eggs were found in the alimentary canal as in the first mouse, and in addition there were three embryos in the small intestine.

Experiment VII. August 3, 9 a. m., a guinea-pig wes fed with mature eggs 59 days old. August 4, 8 a. m., eggs were found in the feces; 10 a. m. (twenty-five hours after feeding) the animal was killed. A few eggs were found in the stomach and large intestine, but none in the small intestine. No embryos were found.

Experiment VIII. August 20, 2 p. m., ripe eggs 35 days old were given to a guinea-pig. August 21, 9 a. m. (nineteen hours after feeding) the animal was killed. A few eggs were found in the stomach and small intestine, some in the large intestine. No embryos were found.

Experiment IX. August 20, noon, ripe eggs 35 days old were fed to a rat with biscuits. The animal did not eat all of the biscuits until the next day. August 22, 10 a. m. (forty-six hours after feeding) the rat was killed. A few eggs were present in the stomach and lower part of small intestine. In the cecum there were three free dead embryos and a half hatched embryo, as well as numerous eggs, and in the upper part of the large intestine there were two free dead embryos and abundant eggs.

Experiment X. August 24, 4 p. m., three mice were fed with ripe eggs 35 days old. August 25, 9 a. m. (seventeen hours after feeding) one mouse was killed. A few eggs were found in the stomach and small intestine, and they were numerous in the cecum and large intestine, but there were no embryos; 12 noon (twenty hours after feeding) another of the mice was killed. The findings were similar to those in the first mouse. August 30, 11 a. m. (six days after feeding), the remaining mouse was killed. There were no eggs in the alimentary canal. The liver and lungs were normal.

Apparently the eggs used in Experiment X did not have sufficient life to develop. This was probably due to the fact that the culture from which the eggs was taken, together with other cultures, was exposed on August 24 to strong direct sunlight in an attempt to determine whether the sunlight would accelerate development. The contrary was thus proved to be true.

It is impossible to draw a conclusion from the six foregoing experiments with regard to the hatching place of the eggs, though the evidence, combined with that of previous investigators, favors the small intestine.

The average time of retention of eggs in the animals appears from our records of these experiments to be from 2 to 5 and usually 3 days. There were always some mature eggs among the greater number of immature eggs evacuated. It seems reasonable to assume that these apparently fully matured and healthy eggs were internally injured in such a way as to make further development impossible. It is clear that not all the mature eggs develop, especially in the case of a young culture. To obtain a heavy infection with Ascaris larvae it is necessary to use large quantities as completely developed as possible (40 days or more). The failure of many investigators to observe development of Ascaris within the animal host was perhaps due to lack of recognition of this point.

Migration of Larvae in the Body of Host

From the foregoing experiments, and from those of previous investigators, it seemed probable that the ripe eggs of Ascaris hatch in the intestine of the animal within 12 to 19 hours, after which the larvae migrate into the other organs, particularly the liver and lungs. The following experiments demonstrate this latter point.

Experiment XI. June 23, 1916, two guinea-pigs were fed with mature eggs 40 days old. June 26 (seventy-seven hours after feeding) one pig was killed by mistake. Two small nematode larvae were found in the liver which afterwards proved to be young Ascaris. The remaining pig was killed June 30. It was impossible to find any nematode larvae in the liver. On opening the pleural cavity, however, the lungs were found to show heavy hemorrhage and to contain two small nematode larvae a little larger than those found in the liver in the preceding experiment.

Experiment XII. August 8, 1917, ripe eggs 66 days old were fed to a guinea-pig. Three days later the pig was killed. The liver, which was normal in color and in size, contained eight larvae. The lungs were normal.

Experiment XIII. August 3 and 4, a guinea-pig was fed with ripe eggs 59 and 60 days old, respectively. The animal was killed on August 7. The liver and lungs were externally normal. Eighteen larvae were found in the former.

Experiment XIV. August 10, a guinea-pig was fed with ripe eggs 66 days old. The pig was killed August 14. The liver was apparently normal, though somewhat lighter in color, and contained twelve larvae. The lungs were normal except for slight reddish spots and contained three of the worms.

Experiment XV. August 29, a guinea-pig was fed with mature eggs incubated in artificial gastric juice at 37 to 38° C. for six days, and also with some incubated in a 1 per cent. solution of sodium bicarbonate at the same temperature for five days. On September 3 the animal was killed. The liver was apparently normal, but faintly hemorrhagic and slightly lighter in color. It contained sixteen larvae. The lungs were somewhat spotted and contained nine of the worms.

Experiment XVI. July 24, a quantity of mature eggs 49 days old were given to a guinea-pig. Feeding with the eggs from the same lot was repeated on July 27. On August 1 the animal was killed. The surface of the lungs was covered with reddish or dark spots due to new and old hemorrhages, and fourteen specimens were obtained from it. Two larvae were found in the liver, one in the trachea and one in the small intestine (dead).

Experiment XVII. A guinea-pig was fed with a small quantity of feces containing ripe eggs and with mature eggs from a culture 56 days old on July 31, and again on August 1. The animal was killed on August 8. The lung surfaces were covered with hemorrhagic spots, and sixty-four specimens of larvae were collected from them. The other organs gave negative results.

Experiment XVIII. July 24, ripe eggs 49 days old were given to two young rats with food, which was not all eaten until the next day. The rats were put into separate cages on July 27, and rat A was fed with a large dose of ripe eggs. Rat B was killed on July 30. The liver only yielded specimens of the worms, two being contained in it. Rat A was killed August 2. The lungs were somewhat spotted with hemorrhages and contained eight worms. The other organs were negative.

The foregoing experiments indicate that the completely matured eggs hatch in the intestine, whence the larvae migrate to the liver, lungs, and trachea, returning finally through the pharynx to the intestines. The liver is apparently not affected by the larvae, but the lungs usually show considerable hemorrhage.

The Fate of the Larvae in the Body of the Feeding Animal

The larvae finally reaching the intestine in these feeding animals are apparently not able to develop into adult form there, being voided with the feces within a few days, presumably because the animals are not the normal host of the parasite. Hence, it seemed reasonable to suppose that completely developed larvae from the lungs or trachea of feeding animals, when ingested by the human being, will grow into adult form in the human intestine. To determine this point 35 specimens of larvae from the lungs of a guinea-pig were taken by the writer on August 8. The details of the experiment will be described later.

The following several experiments were made to determine the period during which the larvae appear in the various organs of the feeding animals.

Experiment XIX. October 11, 1917, two guinea-pigs were fed with ripe eggs, 42 days old. Twenty-four hours later guinea-pig A was killed. Embryos were not found in any part of the alimentary canal or even in the abdominal cavity, and only a few in the stomach and intestine. Guinea-pig B was killed on October 19. Six large larvae (2 mm. in length) were found in the left lung, which was severely hemorrhaged, and three in the trachea.

Experiment XX. November 27, six guinea-pigs were fed with ripe eggs, 68 days old. Guinea-pig A was killed on the next day, and two living larvae were found in the large intestine, but none in other organs. Animal C was found dead on December 3. The liver was slightly infected, but the lungs were heavily hemorrhaged and consolidated. The upper part of the trachea contained two larvae. Animal D was found dead on December 5. The liver was normal. The lungs were dark brown, hemorrhagic, and contained numerous larvae. A few larvae were found in the trachea. Animal E was killed on December 9. The lungs were extremely hemorrhagic, consolidated and dark brown in color, but contained no larvae. Two larvae were found in the trachea and five dead ones in fecal pellets from the rectum. Animal F was killed on December 10. Lungs: As in the preceding animal. One specimen was found in the lung, and three in the large intestine, but none in the trachea.

Experiment XXI. December 12, two guinea-pigs were fed with ripe eggs, 85 days old. Animal A was found dead on December 14. The liver was heavily infected with the larvae. The abdominal cavity was free from the larvae. Guinea-pig B was killed on December 15. The liver was severely infected. The lungs were slightly hemorrhagic and contained a few larvae.

Experiment XXII. October 29, ripe eggs, 60 days old, were given to two guinea-pigs, one of which was found dead on November 1 (animal A). The liver was severely infected with larvae. The other organs were free. Animal B was killed on November 7. The liver was normal. The lungs were spotted with dark brown color, and the anterior lobe of the left lung was consolidated. Numerous larvae were found in the lungs and trachea, one dead specimen in the small intestine, and four living and one dead larva in the large intestine. The trachea contained three specimens in the upper portion, twenty-four in the middle portion and fifty-one in the lower. Fifty of these completely developed living specimens were later ingested by the writer. They varied from 1.23 to 1.62 mm. in length.

Experiment XXIII. November 10, two guinea-pigs were fed with ripe eggs, 54 days old (to A) and 72 days old (to B). B was killed November 14. The liver was heavily infected, and the lungs slightly hemorrhagic and apparently consolidated. Three specimens of larvae were found in the heart. Animal A was found dead on November 25. The outer surface of the lungs was light red and the inner surface dark red in color. They were hemorrhagic and consolidated. Three specimens were present in the left lung, six in the trachea, which contained a small quantity of bloody mucus, and two dead larvae in the large intestine.

Experiment XXIV. November 15, a guinea-pig (A) was fed with ripe eggs, 57 days old, cultivated in a 0.5 per cent. solution of hydrochloric acid, and another (B) with eggs of the same age cultivated in a 0.2 per cent. solution. A was found dead on the 20th. The liver was infected with larvae, and the lungs were hemorrhagic, consolidated and contaminated with numerous larvae. Animal B was found dead on November 22. The liver was slightly infected. The lungs were severely hemorrhaged and apparently consolidated. Abundant larvae of small size were found in the organ. The trachea contained a small quantity of bloody mucus in which numerous larvae were found.

Experiment XXV. November 17, two guinea-pigs were fed with fully matured eggs, 59 days old cultivated in a 0.1 per cent. solution of carbonic acid. A was found dead in the morning of the 22d. The larvae were found in the liver and lungs, and the latter was dark brown in color from heavy hemorrhage. The trachea contained a small quantity of bloody mucus in which three small larvae were present. Animal B was found dead November 26. The liver was free from the larvae. The lungs were dark brown from hemorrhage, consolidated, and contained numberous larvae of various sizes. There were also larvae in the trachea.

Experiment XXVI. November 8, guinea-pig A was fed with ripe eggs, 58 days old, and B with ripe eggs cultivated in a 0.3 per cent. solution of carbonic acid for seventy days. C received mature eggs 70 days old. Animal A was killed on the 13th. The liver and lungs were infected, the trachea free. The lungs contained light and dark red hemorrhagic spots. Two larvae were found in the heart. B was found dead on November 17. The lungs were dark brown with light red margin and were somewhat infected with larvae. Numerous larvae were found in the trachea and six in the large intestine. C was found dead on November 19, and eight large specimens (1.75 to 1.91 mm. long) were found in fecal pellets from the rectum.

Experiment XXVII. November 16, two guinea-pigs were fed with eggs 58 days old. Animal A was found dead on the 24th. The liver contained a few worms. The lungs showed heavy hemorrhage and contained numerous specimens of the worm. The trachea contained some blood and two larvae. B was killed on November 26. The lungs showed severe hemorrhage, were consolidated, and contained a few larvae. The trachea and large intestine also contained a few.

Experiment XXVIII. October 20, two guinea-pigs were fed with eggs 51 days old. Animal A was lost; B was found dead on the 29th. The liver was free. The lungs were somewhat hemorrhagic and contained numerous larvae.

Experiment XXIX. October 20, a guinea-pig was fed with ripe eggs cultivated in a 0.1 per cent. solution of carbonic acid for 51 days. It was found dead on the 29th. The lungs were severely hemorrhaged and consolidated, and large larvae were abundant in the lungs and trachea. Three living larvae were also found in the large intestine.

Summary of Experiments XIX to XXIX

The larvae first appear in the liver on the second day (about 44 hours after feeding), and they are present until the sixth or seventh day, being most abundant on the third, fourth and fifth days, and disappearing after the eighth day.

As Experiments XXI and XXIII show, the larvae are first found in the lungs on the third or fourth day, and a few persist even to the fourteenth or fifteenth day after feeding. They are most abundant from the sixth to the eighth day.

In the trachea the larvae appear first on the fifth or six day and persist as long as they are present in the lungs, being most abundant on the eighth and ninth days. From the trachea they migrate into the mouth and thence down the alimentary tract of the host. The appearance of larvae in the alimentary tract begins after the eighth day. They are rarely found in the esophagus, stomach and small intestine, apparently passing through rapidly, but accumulate in the cecum and large intestine, where some of them are found dead. All are sooner or later voided in the feces.

Severely infected lungs are almost always hemorrhagic, consolidated, and dark brown in color. Epistaxis was not encountered in the animals of these experiments, but Stewart has reported its frequent occurrence in the infected rat.

Experiments on Other Mammals

Further experiments with regard to migration were made in other mammals and in the human body. For this purpose the rabbit, cat and monkey were used.

Experiment XXX. January 22, 1918, two monkeys were fed with large quantities of ripe eggs 76 and 87 days old. A was again fed with a large dose of eggs, 91 days old, on the 26th. B was found dead on the 29th, and Ascaris larvae were found in the lungs. Monkey A was killed on February 1. No larvae were found in the liver. The lungs were heavily infected. Two larvae were found in the trachea, large quantities in the stomach, and a few in the small intestine. The lungs were slightly hemorrhagic and consolidated.

Experiment XXXI. March 9, a cat was fed with eggs 131 days old. March 11, there was another feeding from eggs of the same lot. The animal was killed on the 18th. The lungs were slightly hemorrhagic and infected.

Experiment XXXII. A rabbit was thrice fed with Ascaris eggs, on December 29, 1917; January 21, and March 9, 1918. On March 19 the rabbit was killed. The lungs were slightly hemorrhagic and infected with numerous larvae. A few larvae were present in the trachea and small intestine.

From these experiments it is concluded that the migration of Ascaris larvae is definite in any feeding animal in which the larvae are alive. It was therefore to be supposed that they follow the same course in the human body as in the feeding animals. Personal experiments later confirmed this belief.

Experiments on Immunity

The next point to determine was whether or not the infected animal requires any protection against a second infection with Ascaris larvae.

Experiment XXXII. The intervals between the first and third and between the second and third feedings were seventy and forty-seven days, respectively. The rabbit was killed on the tenth day after the feeding, and its lungs, trachea and small intestine were infected with the larvae.

Experiment XXXIII. January 21, a guinea-pig was fed with ripe eggs 81 days old. March 7, it was again fed with eggs 91 days old. The animal was killed on March 14, seven days after the last feeding. The liver and lungs were slightly infected and the latter somewhat hemorrhagic.

The animals in these two experiments, having recovered from the earlier infections, apparently had no protection against subsequent ones.

Experiment XXXIV. January 23, a guinea-pig was fed with eggs 78 days old; March 7 the feeding was repeated with eggs 129 days old. It was killed on March 18. No larvae were found.

Experiment XXXV. Two successive feedings of eggs 129 days old were given on March 7 and March 9. When it was killed on the 27th, eight days after the last feeding, it was found to be uninfected.

The results of the two last experiments might be ascribed either to the presence of an immunity acquired by the previous infection or to the inability of the eggs used in the second feeding to develop, the eggs having been in dry condition for some days. Stewart has reported a case in which the rat was immunized by one infection with Ascaris larvae. Prof. Fujinami reported the immunization of a horse by one heavy infection with *Sch. japonicum.*

The Migrating Power of the Larvae

Experiment XXXVI. On March 16 Ascaris larvae from the liver of a guinea-pig killed sixty-seven hours after feeding were injected into the abdominal cavity of two guinea-pigs. Guinea-pig A was killed March 23. The lungs were slightly hemorrhagic and infected. B was killed on the following day. The condition of the lungs was the same as in A. The small portions of the middle lobes on both sides were dark gray in color and evidently consolidated.

It was not determined in this experiment by what route the injected larvae migrate into the lungs — by the blood vessel after penetrating the liver, or by penetrating the lungs from the surface after passing through the diaphragm. The experiment gives clear evidence, however, of the power of the larvae to pass through the tissues of the host. Nor it is precisely determined by what route the larvae migrate from the intestine to the liver and from the liver to the lungs of the experimental animal. It is thought that there are three routes by which the larvae may pass from the intestine to the liver: (1) by the blood vessels distributed on the wall of the alimentary canal; (2) by the common bile duct, and (3) by penetrating through the intestinal wall and through the surface of the liver. The route last mentioned seems most probable from Experiment XXXVI, but none of my attempts to determine this point were successful. Stewart supposed that the larvae penetrating the alimentary wall are carried into the liver by one of two routes, by the mesenteric venules or by the bile duct, he did not determine which.

Between liver and lungs two courses of migration are supposed to exist, the blood vessel and the body cavity. Experiments XXIII and XXVI seem to favor the former, but Experiment XXXVI suggests that the latter course is possible. Further investigations on this subject are being carried out.

Human Experiments with Ascaris Larvae

On August 8, 1917, the writer swallowed 35 larvae of various sizes taken from the lungs of a guinea-pig killed on the seventh and eighth days, respectively, after two feedings. Examinations of the feces for the eggs on September 1, 8, 13, 17, October 19 and November 8 were negative, probably because the larvae were not completely developed. Hence larger larvae from the lungs or trachea were used in the second experiment. October 19, 1917, five specimens (2 mm. long) were swallowed. These were taken from the lungs of the guinea-pig killed on the eighth day after feeding. On November 7, 50 specimens were ingested, 1.61 mm. long and coming from the trachea of a guinea-pig killed on the ninth day after feeding. Examination of feces for the eggs on December 8, 18, 29 and January 8 were negative. On January 21, 75 days after the last feeding, however, numerous eggs were present in the feces. Since that time it has often been possible to find the eggs in the feces, and since there is no other explanation of the infection it is reasonably certain that it is the result of these experiments.

Morphological Changes in the Larvae During Development

The detailed study of this part of the subject is not yet complete. The embryo in a mature egg coils its body once or twice within the shell and is actively mobile. The larva just emerged from the egg-shell is slender, cylindrical in shape, with a rounded anterior and pointed posterior extremity, the latter conical and slightly turned toward the dorsal side. The anus is ventrally situated at the base of the conical portion of the posterior extremity. A small portion of each extremity is homogeneous and transparent in appearance, the anterior being a little larger than the posterior end. The greater portion of the body is internally granulated, indicating the intestine and the lower part of the esophagus.

The larvae in the intestine, liver, and lungs are also very active and are always coiled, like the adult form. It is perhaps a characteristic movement of the species. Embryos measured varied in size from 0.23 to 0.27 mm. in length and from 0.013 to 0.017 mm. in breadth.

The larvae in the liver as they mature become differentiated in organization. Three lip-like processes on the front of the body become more visible. The esophagus, which occupies one-third of the intestinal tract, takes a definite form, its posterior end being slightly swollen, its wall very thick, and the lumen very thin but clearly visible. Near the middle of the esophagus there is presently recognizable a group of cells which should be the foundation of the nervous ring of the adult form. The intestine is also differentiated in that the thick wall and the thin lumen are distinguishable. It runs straight along the median line of the body and occupies two-thirds of the length of the digestive canal. A cellular layer of the body wall may be easily distinguished from that of the intestinal wall by a thin space which is regarded as the body cavity. The genital area appears as a distinct cell in the ventral side at about one-third of the body length from the posterior end.

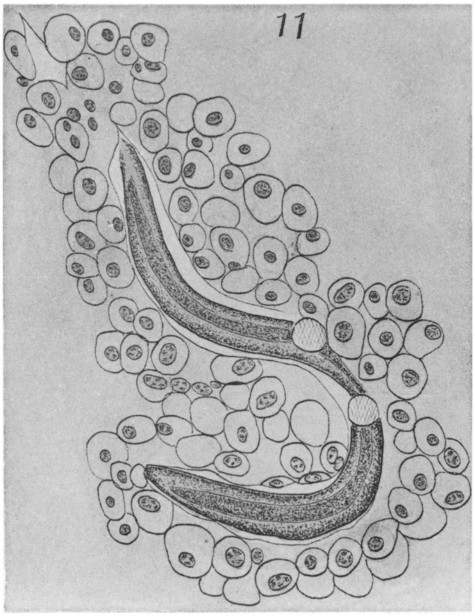
Table 1 shows the measurements of various parts of the body in living specimens.

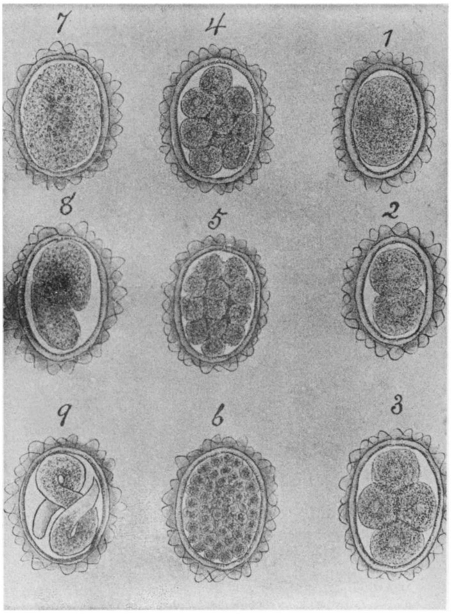
TABLE 1.—Data from Living Specimens

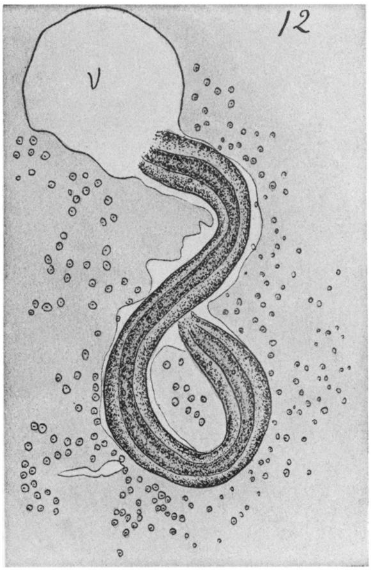
	Total Length mm.	Maximum Breadth mm.	Length of Esophagus mm.	Distance of Anus from Posterior End mm.
1	0.364	0.021	0.1	0.25
2	0.417	0.02	0.117	0.026
3	0.435	0.025	0.107	0.022

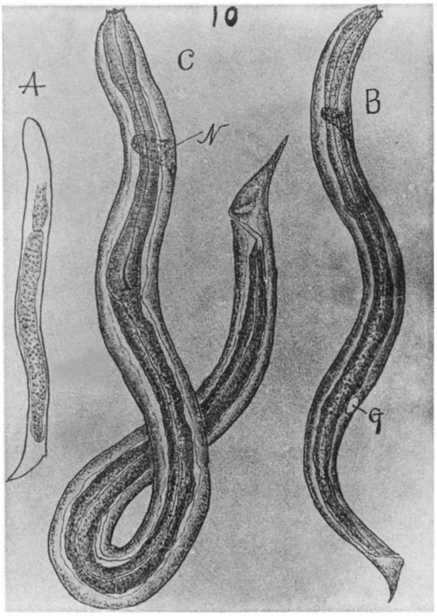
In the lungs the larvae become thrice or four times as large as those in the liver, but there is no remarkable difference in structure. The differentiation of organs become daily more apparent. They vary in size according to the date of infection and are found in the blood vessels, alveoli and bronchi. The intestine of the fully grown larva in the lungs is yellow or light brown in color, perhaps due to food particles.

Table 2 shows the measurements of specimens mounted in potassium acetate or in glycerin.









del S. O. Yoshida.

TABLE 2.—Specimens Mounted in Potass. Acetate or Glycerine

	Body Length mm.	Maximum Breadth mm.	Length of Esophagus mm.	Distance of Anus from Posterior End mm.
1	1.90	0.056	0.28	0.062
2	1.70	0.052	0.26	0.061
3	1.62	0.053	0.26	0.06
4	1.45	0.051	0.25	0.06
5	1.23	0.047	0.23	0.055
6	1.014	0.042	0.2	0.053
7	1.857	0.042		
8	0.857	0.034	0.178	0.050
9	0.846	0.039	0.228	0.050
10	0.666	0.038		
11	0.657	0.030	0.214	0.052
12	0.571	0.028	0.125	0.035
13	0.385	0.028	0.128	0.035
14	0.357	0.028	0.072	0.032
15	0.300	0.021	0.064	0.025

The larvae in the trachea and alimentary canal are similar to the fully developed ones in the lungs.

It is my pleasant duty to express my sincere thanks to Prof. A. Sato, Director of the Osaka Medical Academy, for his kind advice and help during the course of this work. I am also indebted to several other persons who have given me cordial assistance in the investigation.

Explanation of Plate

Figs. 1-9. Stages of development of Ascaris egg. × 300.

Fig. 10. Embryo just hatched in the intestine of guinea-pig. × 233.

Fig. 11. Larva from the liver of guinea-pig. × 233.

Fig. 12. Larva from the lung of guinea-pig. × 233.

Fig. 13. Larva in the liver of guinea-pig. × 500.

Fig. 14. Larva in the lung of guinea-pig. × 300.

Abbreviations: g, genital cell; n, nerve ring; o, dust; v, alveola.

[Editor's Note.—This paper appeared originally in Japanese, in the *Tokyo Iji Shinshi* (Tokyo Medical Weekly Journal). Through the courtesy of the author and the cooperation of the editor, a copy of the original plate is included in each copy of this journal.]